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Efficacies of Chlorfenvinphos, Amitraz and Alphacypermethrin Acaricide Combinations on *Rhipicephalus* (*Boophilus) decoloratus* Adult Ticks and Larvae, from Cattle in Nandi County, Kenya

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Abstract: ***The acaricides chlorfenvinphos, amitraz and alphacypermethrin are commonly used to control cattle ticks in Nandi County, Kenya. Their efficacies are reportedly low, and farmers occasionally combine different classes in effort to improve it. However, their use at irregular concentrations has been documented. Engorged adult Rhipicephalus (Boophilus) decoloratus ticks were recovered from cattle dipped with either of the acaricides three days earlier, and their incubation yielded large batches of eggs that hatched to active larvae. Adult Immersion Tests in combinations of equal volumes of any two of the three acaricides, at recommended concentrations, produced 0 - 100% efficacies after 96 hours. In contrast, Modified Larval Packet Tests had 95 - 100% (Prob > F = 0.000) efficacies on their larvae in 24 hours. Combinations with chlorfenvinphos had high efficacies on adult ticks from cattle dipped in either alphacypermethrin or amitraz (Prob > F = 0.0000). Amitraz-alphacypermethrin combinations had low efficacies on all adult samples. The study showed that combinations of chlorfenvinphos with either amitraz of alphacypermethrin improved efficacies on the adults, while all combinations were effective on the larval stages.***

Keywords: acaricides, combinations, efficacies, Nandi County

1. Introduction

Ticks and tick-borne diseases are among the challenges to dairy cattle development in Kenya (Wesonga et al, 2010). The tick *R. (B) decoloratus* is common in Nandi County, where it is an important parasite and vector for *Anaplasma marginale* and *Babesia bigemina* pathogens. The tick often occurs in large populations on cattle, where they cause irritation, anaemia, wounds and reduced productivity (Mwangi *et al*, 1998). Dipping a weekly dipping regime with either chlorfenvinphos, amitraz or alphacypermethrin acaricide, viable ticks were found on the cattle (Yegon *et al*, 2018; Wangila, 2016). Farmers often mixed different classes of acaricides in attempts to synergize their efficacies on the ticks (Yegon et al., 2016). Combining acaricides can either improve or reduce efficacies of acaricides, with corresponding effect on control of ticks (Dumont et al, 2015).

This study investigated the effects of chlorfenvinphos-amitraz, chlorfenvinphos-alphacypermethrin and amitraz-alphacypermethrin combinations on *R. (B). decoloratus* adults and their larvae. Each combination was made with 50mls of the respective acaricides that were diluted to their recommended dipping concentrations.

2. Materials and methods

Visibly engorged adult female *R.(B). decoloratus* ticks were collected from cattle that had been dipped in either chlorfenvinphos, amitraz or alphacypermethrin acaricides three days earlier. The ticks were pooled into groups according to class of acaricide used on cattle, before washing in plain water and drying on blotting paper. Samples from each group were subjected to AIT in fresh chlorfenvinphos-amitraz, chlorfenvinphos-alphacypermethrin and amitraz-alphacypermethrin mixtures, as described by Drummond *et al*., (1973). The larvae from each tick group were subjected to the MLPT, in the mixtures, as described by Stone and Haydock (1962) and modified by FAO (1984). The ticks were observed for mortalities after 24, 48 and 96 hours from exposure. Data analysis was done with Abbott's Formula (Abbots, 1925).

3. Results

Assessment of the efficacies combined acaricides on adult stages

Notable mortalities were observed on the adult ticks after 96 hours from exposure **(Tables 1 & 2)**. The mixture of chlorfenvinphos-amitraz had a 100% efficacy (Prob > F = 0.000) on amitraz group of ticks and 83.33% (Prob > F = 0.0002) on the alphacypermethrin group. No effects were observed on the chlorfenvinphos group. The chlorfenvinphos-alphacypermethrin mixture that had 75% efficacy on the ticks that survived dipping in alphacypermethrin, and 70.83% on those from amitraz dips. The amitraz-alphacypermethrin mixture had low efficacies on ticks that survived dipping in either of the three acaricides, while the other two mixtures were ineffective on the ticks from cattle dipped in chlorfenvinphos.

Table 1: Efficacies of combined acaricides on adult ticks

Dead ticks after 96 hours				
Tick group	Ticks exposed to:	Mean	Std. Dev	Efficacy %
Alphacypermethrin	Control (Plain water)	0	0	
	Chlorfenvinphos-Amitraz	10	1.41	83.33
	Chlorfenvinphos-Alphacypermethrin	9	1.41	75
	Amitraz-Alphacypermethrin	2.5	2.12	20.83
Amitraz	Control (Plain Water)	0	0	
	Chlorfenvinphos-Amitraz	12	0	100
	Chlorfenvinphos-Alphacypermethrin	8.5	2.12	70.83
	Amitraz-Alphacypermethrin	7	1.41	58.33
Chlorfenvinphos	Control (Plain Water)	0	0	
	Chlorfenvinphos-Amitraz	0	0	0.00
	Chlorfenvinphos-Alphacypermethrin	0.5	0.71	16.67
	Amitraz-Alphacypermethrin	1	0	33.33

Table 2: The efficacies of combined acaricides on adult ticks (ANOVA)

Tick group	Source	SS	Df	MS	F	Prob > F
Alphacypermethrin	Between groups	189.6	3	63.2	44.61	0.0002
	Within groups	8.5	6	1.42		
	Total	**198.1**	**9**	**22.01**		
Amitraz	Between groups	228	3	76	70	0.0000
	Within groups	6.5	6	1.08		
	Total	**234.5**	**9**			
Chlorfenvinphos	Between groups	1.6	3	0.53	6.40	0.0267
	Within groups	0.5	6	0.83		
	Total	**2.1**	**9**			

Assessment of efficacies of combined acaricides on larvae

The combinations had high efficacies on larval stages of all tick groups (Prob > F = 0.0000). The mortalities ranged from 95.45% to 100% in 24 hours from exposure **(Table 3 & 4)**. The chlorfenvinphos-alphacypermethrin combination had an efficacy of 100% on the larvae of the alphacypermethrin and chlorfenvinphos group of ticks, while amitraz-alphacypermethrin produced 100% mortalities on the larvae of amitraz group of ticks.

Table 3: Efficacies of mixed acaricides on larvae (Abbott's Formula)

Tick group	*Larvae exposed to:*	*Mean*	*Std. Dev.*	*Efficacy %*
Alphacypermethrin	Plain water	22	0	
	Chlorfenvinphos-Amitraz	0.5	0.71	97.73
	Chlorfenvinphos-Alphacypermethrin	0	0	100
	Amitraz-Alphacypermethrin	0.5	0.71	97.73
Amitraz	Plain Water	70	0	
	Chlorfenvinphos-Amitraz	0.5	0.71	99.29
	Chlorfenvinphos-Alphacypermethrin	0.5	0.71	99.29
	Amitraz-Alphacypermethrin	0	0	100
Chlorfenvinphos	Plain Water	33	0	
	Chlorfenvinphos-Amitraz	1.5	0.71	95.45
	Chlorfenvinphos-Alphacypermethrin	0	0	100
	Amitraz-Alphacypermethrin	0.5	0.71	98.48

Table 4: The efficacies of combined acaricides on larvae (ANOVA)

Dipping acaricide	**Source**	**SS**	**Df**	**MS**	**F**	**Prob >F**
Alphacypermethrin	Between groups	704.5	3	234.83	939.33	0.0000
	Within groups	1	4	0.25		
	Total	**705.5**	**7**	**100.79**		
Amitraz	Between groups	7280.5	3	2426.83	9707.33	0.0000
	Within groups	2	4	0.25		
	Total	**7280.5**	**7**	**1040.21**		
Chlorfenvinphos	Between groups	1570.5	3	523.5	2094.00	0.0000
	Within groups	1	4	0.25		
	Total	**1571.5**	**7**	**224.5**		

4. Conclusion

Combining chlorfenvinphos and amitraz or alphacypermethrin produced higher efficacies on larval stages of *R. (B). decoloratus* than on adults. The killing effect on larvae occurred in 24 hours from exposure, while it required as long as 96 hours for significant mortalities in adults. The chlorfenvinphos-alphacypermethrin and

chlorfenvinphos-amitraz combinations had higher efficacies on adults from the alphacypermethrin and amitraz group of ticks. All combinations had high efficacies on larvae from all groups of ticks. The results indicated that combinations of some of the acaricides improved efficacies on adults, but enhanced their effects on the larval stages.

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